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(54) **VIBRATION REDUCTION STRUCTURE OF RECIPROCATING COMPRESSOR**

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See application file for complete search history.

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(57) **ABSTRACT**

A vibration reduction structure of a reciprocating compressor comprises: a case having a suction pipe for introducing a refrigerant and a discharge pipe for discharging a refrigerant at both sides thereof; an assembly installed in the case to compress a refrigerant and composed of a cylinder, a piston, a driving unit, and a discharge valve assembly; a loop pipe installed between the discharge valve assembly and the discharge pipe with a curved shape; and a connection unit for connecting a first point of the loop pipe and a second point of the loop pipe facing the first point and thereby reducing a vibration transmission. According to this, vibration generated as the piston is operated can be transmitted to the compressor through many paths including the loop pipe and the additional connection unit. Also, generated vibration can be canceled to each other due to its phase difference, thereby preventing vibration from being transmitted to the entire case. Also, a damage of the connection part of the loop pipe due to vibration can be prevented, and a reliability of the product can be enhanced.

9 Claims, 2 Drawing Sheets

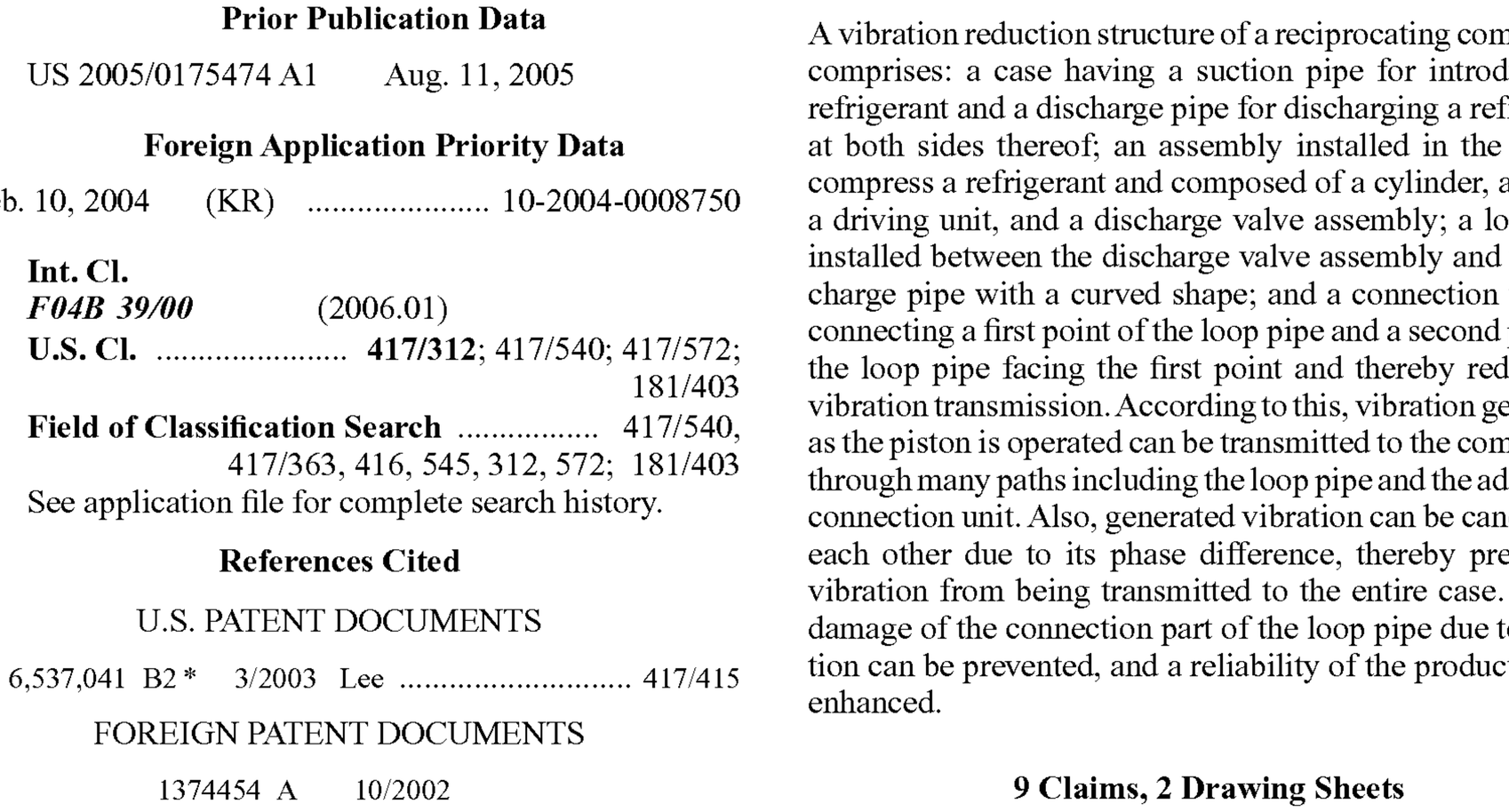


FIG. 1
CONVENTIONAL ART

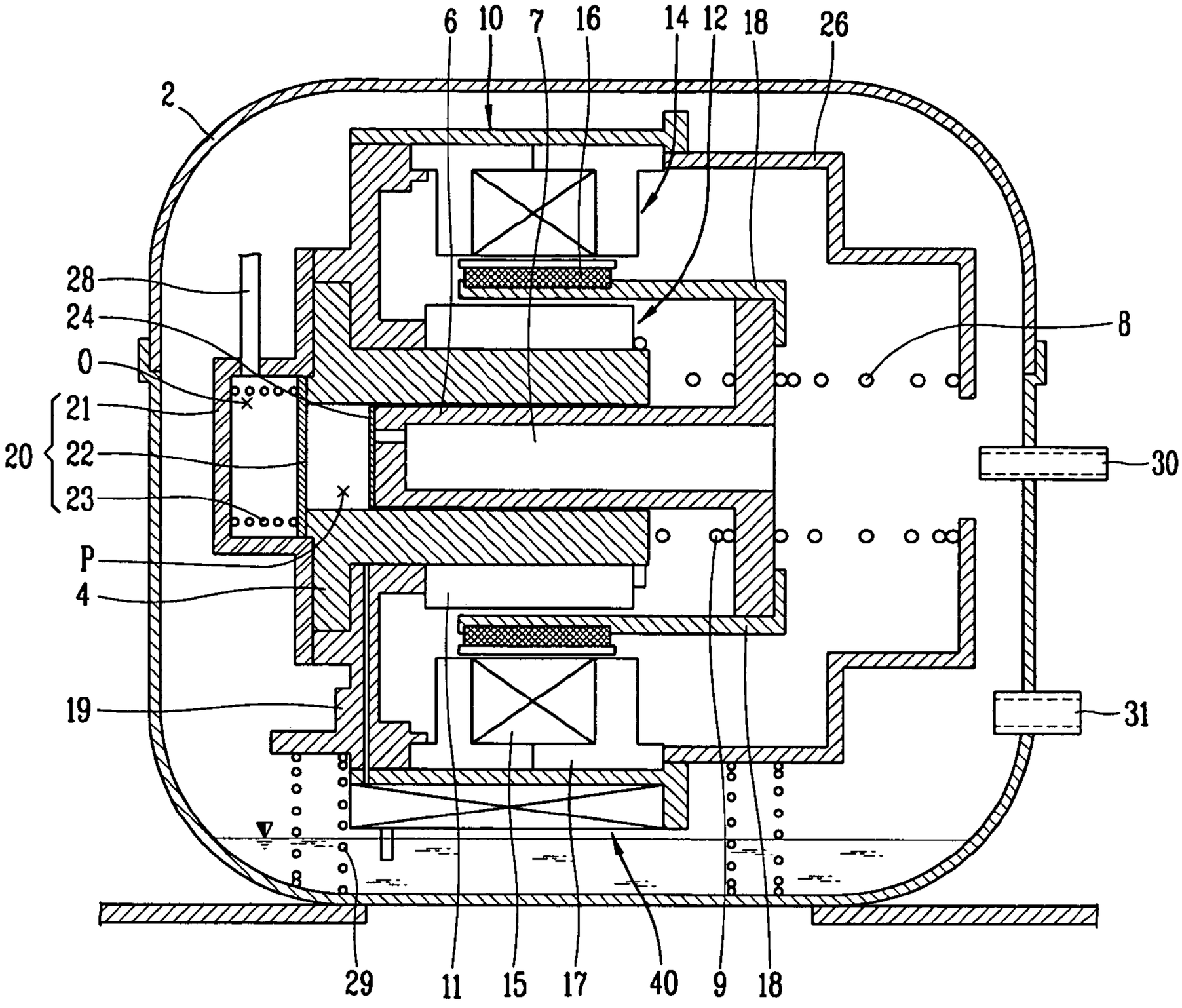


FIG. 2
CONVENTIONAL ART

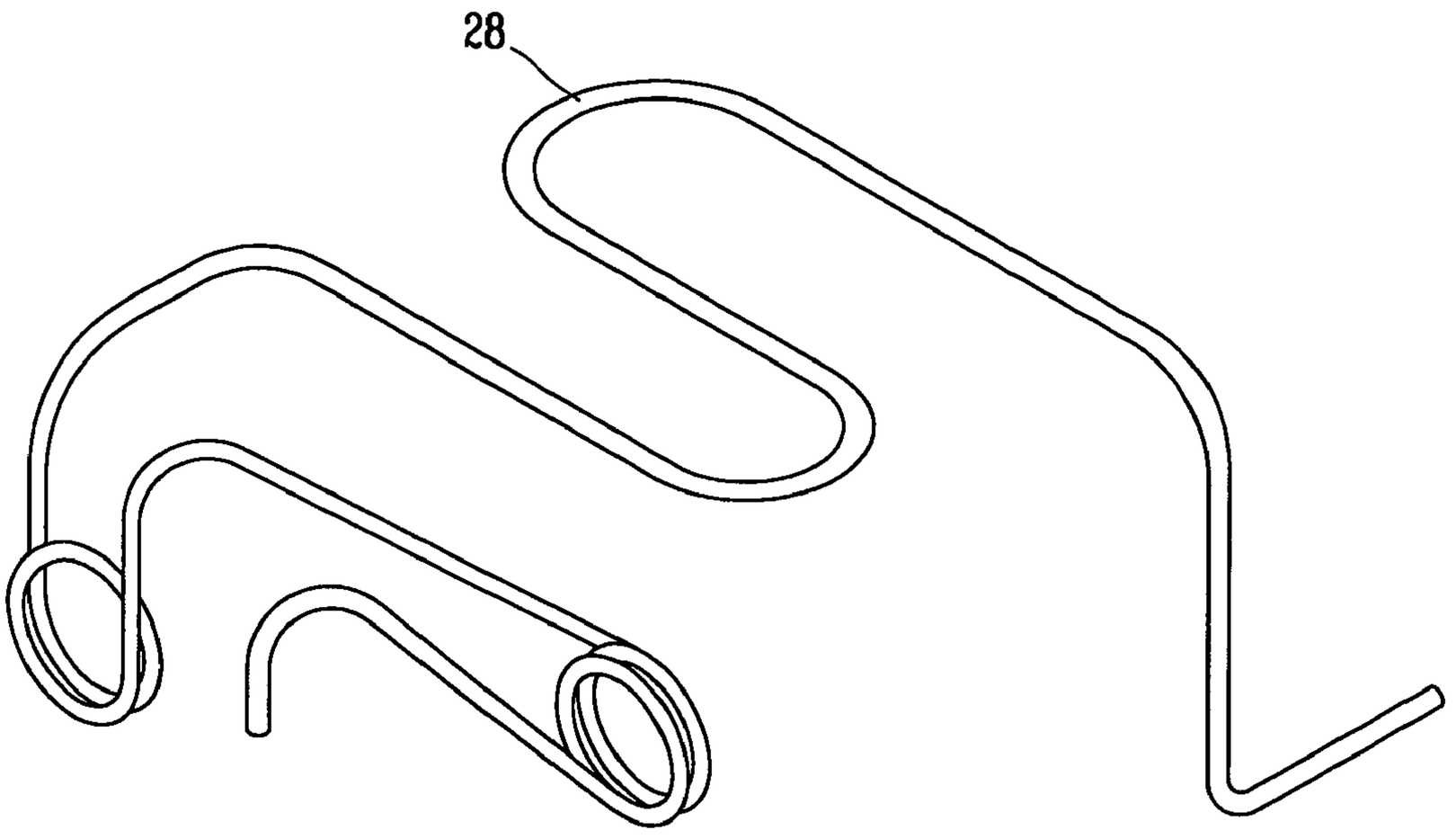
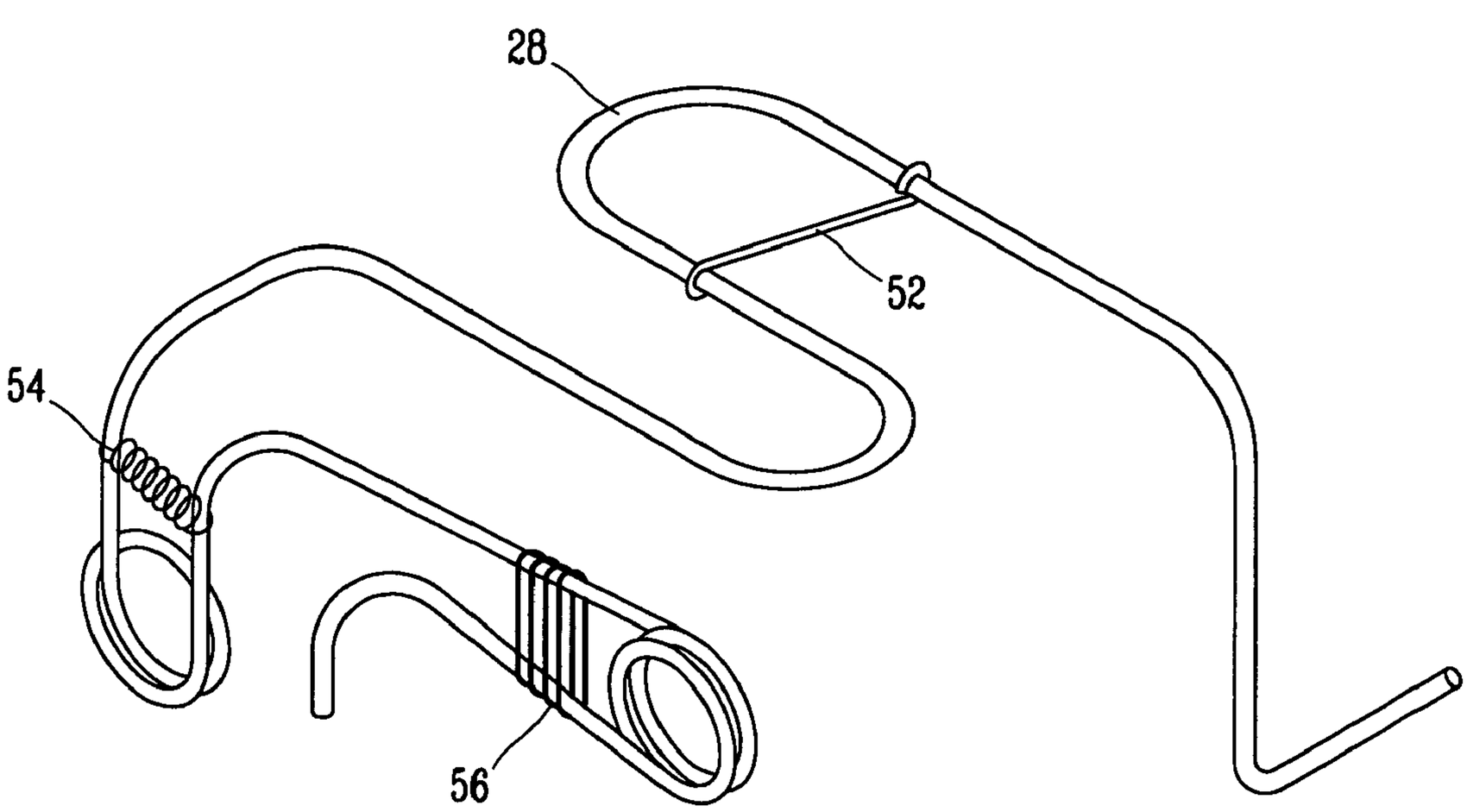


FIG. 3



VIBRATION REDUCTION STRUCTURE OF RECIPROCATING COMPRESSOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a vibration reduction structure of a reciprocating compressor capable of preventing vibration generated from an assembly composed of a piston, a cylinder, and a driving unit from being transmitted to an entire case at the time of operating the compressor, and more particularly, to a vibration reduction structure of a reciprocating compressor capable of effectively reducing vibration by installing a loop pipe between an assembly and a case and installing an additional connection unit at the loop pipe in order to discharge a compressed refrigerant.

2. Description of the Conventional Art

Generally, a compressor is a device for enhancing a pressure by compressing various gas such as air, refrigerant, etc. by receiving power from a power generating device such as an electric motor, a turbine, etc. The compressor is being widely used in home appliances such as a refrigerator, an air conditioner, etc. or throughout the industry.

The compressor can be classified into a reciprocating compressor for compressing a refrigerant as a piston is linearly reciprocated in a cylinder with forming a compression space for sucking and discharging operation gas between the piston and the cylinder; a rotary compressor for compressing a refrigerant as a roller is eccentrically-rotated along an inner wall of a cylinder with forming a compression space for sucking and discharging operation gas between the eccentrically rotated roller and the cylinder; and a scroll compressor for compressing a refrigerant as an orbiting scroll is rotated along a fixed scroll with forming a compression space for sucking and discharging operation gas between the orbiting scroll and the fixed scroll.

Recently, among the reciprocating compressors, a linear compressor having a simplified structure and capable of enhancing a compression efficiency without a mechanical loss due to a motion conversion by directly connecting a piston to a linearly-reciprocating driving motor is being much developed.

FIG. **1** is a lateral section view showing a reciprocating compressor in accordance with the conventional art.

As shown, the general reciprocating compressor compresses operation fluid such as refrigerant, etc. as a piston is linearly reciprocated in a cylinder. FIG. **1** shows a linear compressor among the reciprocating compressor. The reciprocating compressor comprises: a case **2** to which a suction pipe **30** for introducing a refrigerant and a discharge pipe **31** for discharging a refrigerant are connected; a cylinder **4** installed in the case **2**; a piston **6** linearly-reciprocated in the cylinder **4**, for sucking a refrigerant into a compression space P, compressing, and then discharging the refrigerant; a driving unit **10** fixed to an outer side of the cylinder **4**, for linearly-reciprocating the piston **6**; a suction valve **24** installed at one end of the piston **6** that forms the compression space P, for sucking a refrigerant to the compression space P; and a discharge valve assembly **20** installed at one end of the cylinder **4** that forms the compression space P, for discharging a refrigerant from the compression space P to the discharge pipe **31**.

The cylinder **4** is formed as a hollow type so that the piston **6** can be linearly-reciprocated therein, and is provided with the discharge valve assembly **20** at one end thereof.

The piston **6** is provided with a refrigerant channel **7** at a center thereof so that a refrigerant introduced from the suction pipe **30** can flow, and is inserted into the cylinder **4** thereby to form a compression space P at one side thereof. Also, one end of the piston **6** is elastically supported by a supporting frame **26** separately installed from the cylinder **4** by restoration springs **8** and **9** installed in an axial direction.

The driving unit **10** is composed of: a cylindrical inner stator **12** fixed to an outer side of the cylinder **4** and formed as a plurality of lamination sheets **11** are laminated in a circumferential direction; a cylindrical outer stator **14** installed at an outer side with a certain interval and formed as a plurality of lamination sheets **17** are laminated on an outer side of a coil **15** in a circumferential direction; and a permanent magnet **16** installed between the inner stator **12** and the outer stator **14** and connected to another end of the piston **6** by a mounting member **18**.

The inner stator **12** and the outer stator **14** are fixed to an outer side of the cylinder **4** by a frame **19**, and the permanent magnet **16** is installed to be linearly-reciprocated with the mounting member **18** and the piston **6**.

The suction valve **24** is formed as a thin plate shape and a center portion thereof is positioned at one end of the piston **6**. The center portion of the suction valve **24** is partially cut to open and close the refrigerant channel **7**, and one side of the suction valve **24** is fixed to one end of the piston **6** by a screw.

The discharge valve assembly **20** is composed of: a discharge cover **21** installed to form a discharge space O at a side of one end of the cylinder **4**; a discharge valve **22** for opening and closing one end of the of the cylinder **4**; and a valve spring **23** installed between the discharge cover **21** and the discharge valve **22**, for providing an elastic force in an axial direction.

A curved loop pipe **28** is installed between one side of the discharge cover **21** and the discharge pipe **31**. The loop pipe **28** guides a compressed refrigerant to be discharged outwardly, and prevents vibration generated by a reciprocal operation among the cylinder **4**, the piston **6**, and the driving unit **10** from being transmitted to the entire case **2**.

FIG. **2** is a perspective view showing the loop pipe of the reciprocating compressor in accordance with the conventional art. When a natural frequency of the loop pipe **28** is equal or similar to an operation frequency of the piston **6**, a resonance is occurred. Therefore, in order to prevent the resonance occurrence, the loop pipe **28** is designed to have a natural frequency that is not equal or is not similar to the operation frequency of the piston **6**, thereby preventing vibration and noise from being transmitted to the case **2**.

The cylinder **4**, the piston **6**, the driving unit **10**, and an oil supplying device **40** are connected to one another thereby to form an assembly. The assembly is installed in the case **2** to be supported by a buffering device such as a supporting spring **29**, etc.

The oil supplying device **40** for supplying oil stored at an inner lower side of the case **2** to a space between the piston **6** and the cylinder **4** is installed at a lower side of the frame **19**, thereby preventing a friction between the piston **6** and the cylinder **4** and cooling the cylinder **4**.

In the conventional vibration reduction structure for the scroll compressor, the loop pipe **28** for guiding a refrigerant to be discharged is installed between the assembly and the discharge pipe **31**, and the assembly is supported by a buffering device such as the supporting spring **29**, etc. at the lower side of the case **2**, thereby reducing vibration.

Since the loop pipe **28** is curvedly formed so that a vibration transmission path can be longer, vibration generated from the assembly is reduced while being transmitted along the loop pipe **28**. At this time, the supporting spring **29** reduces vibration generated from the assembly in the up-down direction.

In the conventional vibration reduction structure for the reciprocating compressor, since the loop pipe **28** is curvedly formed to be welded to the discharge cover **21** and the discharge pipe **31**, a vibration transmission path becomes long and thereby a vibration transmission to the case **2** is reduced. However, there is a limit in making the loop pipe **28** long. Also, in case that the loop pipe becomes different from the original design condition due to various changes of an operation frequency of the driving unit **10** or various external influences, etc., a resonance is occurred and vibration having a comparatively great displacement is generated at a specific part of the loop pipe. The generated vibration is transmitted to the connection part of the loop pipe and thus the connection part is destroyed, thereby degrading a reliability of the product.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide a vibration reduction structure of a reciprocating compressor capable of preventing vibration generated when a piston is driven from being transmitted to an entire case by transmitting the vibration through many paths.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a vibration reduction structure of a reciprocating compressor comprising: a case having a suction pipe for introducing a refrigerant and a discharge pipe for discharging a refrigerant at both sides thereof; a cylinder installed in the case; a piston linearly-reciprocated in the cylinder and forming a compression space, for introducing a refrigerant into the compression space in an axial direction and compressing the refrigerant; a driving unit for linearly-reciprocating the piston; a discharge valve assembly installed at an end of the compression space of the cylinder to be opened and closed, for discharging a compressed refrigerant; a loop pipe installed between the discharge valve assembly and the discharge pipe with a curved shape, for preventing vibration generated from the cylinder, the piston, and the driving unit from being transmitted to the case; and a connection unit for connecting a first point of the loop pipe and a second point of the loop pipe adjacent to the first point and thereby reducing a vibration transmission.

The connection unit is preferably a clip having a hook at both ends thereof, respectively so that one end thereof can be hooked at the first point of the loop pipe and another end thereof can be hooked at the second point of the loop pipe.

More preferably, the hook of one end of the clip is formed to wind the first point of the loop pipe in a forward direction, and the hook of another end of the clip is formed to wind the second point of the loop pipe in a backward direction.

The connection unit can be constructed as a coil spring that one end thereof is hooked at the first point of the loop pipe and another end thereof is hooked at the second point of the loop pipe, or can be constructed as a wire to wind the first point and the second point of the loop pipe several times.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

In the drawings:

FIG. **1** is a lateral section view showing a reciprocating compressor in accordance with the conventional art;

FIG. **2** is a perspective view showing a loop pipe of the reciprocating compressor in accordance with the conventional art; and

FIG. **3** is a perspective view showing preferred embodiments of a connection unit of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

Hereinafter, preferred embodiments of the present invention will be explained with reference to the attached drawings as follows.

A vibration reduction structure of a reciprocating compressor according to the present invention comprises: a case having a suction pipe for introducing a refrigerant and a discharge pipe for discharging a refrigerant at both sides thereof; a cylinder installed in the case; a piston linearly-reciprocated in the cylinder and forming a compression space, for introducing a refrigerant into the compression space in an axial direction and compressing the refrigerant; a driving unit for linearly-reciprocating the piston; a discharge valve assembly installed at an end of the compression space of the cylinder to be opened and closed, for discharging a compressed refrigerant; a loop pipe installed between the discharge valve assembly and the discharge pipe with a curved shape, for preventing vibration generated from the cylinder, the piston, and the driving unit from being transmitted to the case; and a connection unit for connecting a first point of the loop pipe and a second point of the loop pipe adjacent to the first point and thereby reducing a vibration transmission.

The connection unit connects a first point of the loop pipe **28** to a second point of the loop pipe **28** facing the first point.

It is preferable that a plurality of the connection unit are formed.

FIG. **3** is a perspective view showing preferred embodiments of the connection unit of the present invention. The above three embodiments can be applied together one another or individually.

The connection unit **52** is preferably a clip having a hook at both ends thereof, respectively so that one end thereof can be hooked at the first point of the loop pipe **28** and another end thereof can be hooked at the second point of the loop pipe **28**.

More preferably, the hook of one end of the connection unit **52** is formed to wind the first point of the loop pipe **28** in a forward direction, and the hook of another end of the connection unit **52** is formed to wind the second point of the loop pipe **28** in a backward direction.

As a modification example, the connection unit **54** is a coil spring that one end thereof is hooked at the first point of the loop pipe **28** and another end thereof is hooked at the second point of the loop pipe **28**. As the coil spring, a compression coil spring for providing a compression force in a longitudinal direction can be used, or a tension coil spring for providing a tensile force in a longitudinal direction can be used.

As still another embodiment, the connection unit **56** is installed to wind the first point and the second point of the loop pipe **28** several times. The connection unit **56** is preferably constructed as a wire.

The operation and effects of the present invention will be explained as follows.

First, power is applied to the outer stator **14**. According to this, the permanent magnet **16** is moved by a reciprocal electromagnetic force among the inner stator **12**, the outer stator **14**, and the permanent magnet **16**. At the same time, the piston **6** to which the permanent magnet **16** is fixed is linearly-reciprocated in the cylinder **4**, and a refrigerant introduced through the suction pipe **30** is introduced into the compression space P between the cylinder **4** and the cylinder **6** by a pressure difference. Then, the refrigerant is compressed, passes through the discharge valve assembly **20**, and flows along the loop pipe **28** thereby to be discharged to the discharge pipe **31**.

At this time, even if vibration generated as the piston **6** is linearly-reciprocated in the cylinder **4** is transmitted from one side of the loop pipe **28** to another side, the vibration is reduced by the connection unit **52**, **54**, and **56**.

More concretely, since the connection unit is installed to connect the first point of the loop pipe **28** to the second point of the loop pipe **28** adjacent to the first point, vibration passing through the first point of the loop pipe **28** can be transmitted to the second point of the loop pipe **28** through various paths including the loop pipe **28** and the connection unit and thereby the vibration is reduced. Also, vibration transmitted to the second point of the loop pipe **28** along the loop pipe **28** has an opposite phase to a phase of vibration transmitted to the second point of the loop pipe **28** along the connection unit, thereby canceling the vibration.

According to this, even if the compressor is operated, vibration is prevented from being transmitted to the entire case **2**. Also, even if the loop pipe **28** is connected to the discharge cover **21** positioned at a side of the discharge valve assembly **20** or the discharge pipe **31** positioned at a side of the case **2** by a welding, the connection part therebetween can be prevented from being damaged.

In the vibration reduction structure of the reciprocating compressor according to the present invention, the connection unit is additionally installed to connect the first point of the loop pipe to the second point of the loop pipe adjacent to the first point. According to this, vibration generated as the piston is operated can be transmitted to the compressor through many paths including the loop pipe and the additional connection unit. Also, generated vibration can be canceled to each other due to its phase difference, thereby preventing vibration from being transmitted to the entire case. Also, a damage of the connection part of the loop pipe due to vibration can be prevented, and a reliability of the product can be enhanced.

As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalence of such metes and bounds are therefore intended to be embraced by the appended claims.

What is claimed is:

1. A reciprocating compressor comprising:

a case having a suction pipe for introducing a refrigerant and a discharge pipe for discharging a refrigerant at both sides thereof;

a cylinder installed in the case;

a piston linearly-reciprocated in the cylinder and forming a compression space, for introducing a refrigerant into the compression space in an axial direction and compressing the refrigerant;

a driving unit for linearly-reciprocating the piston;

a discharge valve assembly installed at an end of the compression space of the cylinder to be opened and closed, for discharging a compressed refrigerant;

a loop pipe installed between the discharge valve assembly and the discharge pipe with a curved shape, for preventing vibration generated from die cylinder, the piston, and the driving unit from being transmitted to the case; and

a nonelastic connection unit for connecting a first point of the loop pipe and a second point of the loop pipe facing the first point and thereby reducing a vibration transmission,

wherein the nonelastic connection unit includes a nonelastic vibration transmitting element configured to transmit vibration from the first point to the second point of the loop pipe, and

wherein the nonelastic connection unit is installed completely to wind the first point of the loop pipe and the second point of the loop pipe multiple times at multiple locations along a predetermined length of the first and second points of the loop pipe.

2. The compressor of claim **1**, wherein the nonelastic connection unit comprises a plurality of nonelastic connection units.

3. The compressor of claim **1**, further comprising a second nonelastic connection unit including a hook at both ends thereof so that one end thereof can be hooked at a third point of the loop pipe and another end thereof can be booked at a fourth point of the loop pipe.

4. The compressor of claim **3**, wherein the hook of said one end of the nonelastic connection unit is formed to wind the first point of the loop pipe in a forward direction, and the hook of said another end of the nonelastic connection unit is formed to wind the second point of the loop pipe in a backward direction such that the vibration is transmitted from the first point to the second point of the loop pipe.

5. The compressor of claim **4**, wherein the nonelastic connection unit comprises a plurality of nonelastic connection units.

6. The compressor of claim **1**, further comprising an elastic connection unit including a coil spring having one end hooked at a third point of the loop pipe and another end hooked at a fourth point of the loop pipe.

7. The compressor of claim **1**, wherein the nonelastic connection unit does not overlap when the nonelastic connection winds the loop pipe.

8. The nonelastic connection unit of claim **1**, wherein the nonelastic connection unit is a nonelastic wire winding the first point of the loop pipe and the second point of the loop pipe multiple times.

9. The nonelastic connection unit of claim **3**, wherein the nonelastic connection unit is a rod with the hook at the both ends of the rod.

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